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the ton in the state of Louisiana has been increased from 130 pounds to 170 pounds. In the examination of road materials important contributions to technical chemistry have been made by this bureau. The valuable studies on the dietetic value of foods and on their adulterations, conducted under the direction of Dr. Harvey Washington Wiley (1847-) have not only done much towards creating a demand for the enactment of national legislation for pure food, but they have also been praiseworthy contributions to the application of chemistry to sanitation. This bureau also should receive recognition for its fostering influence over the Association of Official Agricultural Chemists, an organization which has done so much to secure uniform methods of analysis of fertilizers and of foods.*

To Henry Carrington Bolton (1843-1903) is due the credit for the series of bibliographies of the literature of the chemical elements that have been published by the Smithsonian Institution. His own memory will always be worthily preserved by the splendid 'Bibliography of Chemistry' in four octavo volumes, an important section of each of which is devoted to technical chemistry.

The records of the past give abundant hope for the future.

MARCUS BENJAMIN.

U. S. NATIONAL MUSEUM.

THE PHYSIOLOGICAL SECTION OF THE
CENTRAL BRANCH OF THE AMERICAN
SOCIETY OF NATURALISTS.

A PHYSIOLOGICAL section of the Central Branch of the American Society of Naturalists was organized and held enthusiastic meetings on March 31 and April 1

* The literature issued by the Bureau of Chemistry is large and includes nearly one hundred important bulletins and many minor circulars and leaflets.

during the recent meeting at Chicago. The sectional meeting was called to order in the Hull Physiological Laboratory and Professor G. N. Stewart was chosen chairman.

The following papers were presented:

Changes in the Percentage of Water in the Central Nervous System of the White Rat between Birth and Maturity: H. H. DONALDSON.

Between birth and one year of age the percentage of water in the brain of the white rat falls from approximately 89 per cent. to 77 per cent., and in the spinal cord from 86 per cent. to 69 per cent.

In the brain the rapid decrease occurs during the first seventy days of life, while in the cord this period is somewhat more prolonged.

Taking the converse change of increase in solids, it is found that in both the brain and the cord the solids increase more rapidly than does the weight of the organ, a relation probably dependent on the process of medullation.

In general, the percentage of water in the central nervous system is very closely correlated with the age of the animal, and almost independent of its absolute body weight.

On the Presence of a Sulphur Compound in Nerve Tissues: WALDEMAR KOCH.

Kossel first called attention to the fact, later confirmed by Cramer, that all preparations of protagon contained sulphur. Thudichum isolated an impure barium salt containing four per cent. of sulphur, which he classed as a cerebrosulphatid.

A comparison of the organically combined sulphur (not proteid sulphur) present in various tissues gives the following result expressed in parts per million: Spinal cord, 1,029; liver, 470; striated muscle, 310; testicle, 209; submaxillary gland, 135. These figures point very

strongly to a sulphur metabolism in the nervous system, as even the liver, which is supposed to play such an important rôle in sulphur metabolism, contains only half as much as the spinal cord. Results indicate that the sulphur compound or compounds exist in the nervous system partly combined and partly free; in the liver they are not combined. Attempts to isolate and purify for analysis a compound containing sulphur have so far been only partially successful on account of the extremely poor yields. A barium salt was obtained, resembling Thudichum's compound, but containing more nitrogen. With regard to solubility and chemical reactions the compound agrees best with Cloetta's uroproteic acid. My barium salt contains, however, twice as much sulphur as Cloetta found, and, besides, a very considerable amount of phosphorus, which either represents an impurity in every case or was present in Cloetta compound also, but not detected by him. My compound calculated as the free acid gives approximately the following formula, $C_{60}H_{120}N_{12}S_2PO_{40}$, as compared with Cloetta's $C_{66}H_{116}N_{20}SO_{54} + nH_2O$. The investigation will be continued as soon as more material is available.

The Excretion of Nitrogen by the White Rat According to Weight and Age:
SHINKISHI HATAI.

A cage for collecting urine and feces separately was especially constructed for the present work. The animals were kept for three days in the cage and were fed exclusively with Uneeda biscuit and water. From the observations on 89 rats, which ranged from 32 grams up to 382 grams, the following results were obtained:

1. The total amount of urine increases with the body weight up to 120 grams, then decreases very decidedly. From 180 grams it again ascends up to 220 grams, where it remains rather constant.

2. The total amount of nitrogen is quite independent of the amount of urine. It increases constantly and continuously as the animals grow in weight. When the total amount of nitrogen is plotted on base line according to the body weight the curve thus obtained presents an approximately straight line. On the other hand, the curve on base line according to age presents a distinct period of rapid rise up to somewhere between 200 grams to 240 grams.

3. About 91 per cent. of the total nitrogen in the case of the young and 89 per cent. in the larger represent the urinary nitrogen.

4. The total amount of nitrogen eliminated by rats of different weights during 24 hours can be determined with a high degree of accuracy by the formula

$$\log N = \frac{233 + \log B. W. \times 3}{4}$$

where N = total nitrogen in milligrams and B. W. = body weight in grams.

Further Evidence of the Fluidity of the Conducting Substance in Nerves: A. J. CARLSON.

The pedal nerves of gasteropods (*Ariolimax*) and the ventral nerve-cord of worms (*Bispira*) have relatively great elasticity and may be stretched to nearly twice their shortest length without impairing their function or altering their condition sufficiently to cause stimulation. This stretching does not affect the intensity of the impulse conducted through the nerves, as shown by the muscular response. But the time required for the impulse to travel through the nerve increases in proportion to the degree of stretching of the nerve in such way that delay in time is directly compensated by the additional length of the nerve in the stretched condition, so that the actual rate of propagation of the nervous impulse remains the same in the

stretched and the relaxed nerve or nerve-cord. The increase in the transmission-time shows that the stretching is not merely a straightening out of kinks or folds in the nerve-fibers. The conducting substance must be actually extended. But this extension of the conducting substance is effected without inducing any changes of stress or tension in it, because the process (nervous impulse) conducted by it is not altered. Such an extension of conducting substance can be effected only in case it is in a fluid condition.

The Antagonistic Action of Calcium to Barium, and of Calcium and Barium to Veratrin, on the Mammalian Heart: S. A. MATTHEWS.

Calcium salts and barium salts show the same antagonism as regards the mammalian heart as Sydney Ringer observed on the heart of the frog. Further, both calcium and barium are antagonistic to veratrin. Barium shows a greater antagonism to veratrin than calcium, but owing to the marked poisonous properties of barium in sufficient doses to counteract the veratrin effects, calcium is necessary to check in part the barium effects, and the antagonism to veratrin is more complete if a solution of $m/2,000$ BaCl_2 made up in an $m/8$ CaCl_2 solution be injected. This also corroborates Ringer's results on the frog's heart.

Determination of Freezing Point of Small Quantities of Liquid, Especially for Clinical Purposes: T. M. WILSON.

Dr. G. N. Stewart suggested that it would be worth while to investigate whether by using a small tube and adding to a small quantity of a solution whose freezing point was to be determined a quantity of a liquid which does not exert osmotic pressure (clean mercury, *e. g.*) suf-

ficiently large to insure complete immersion of the thermometer bulb, fairly satisfactory readings might not be obtained. By performing all the manipulations in a definite way, and, in particular, keeping the degree of undercooling about the same in successive observations, it was found that this was the case. Comparison of the results obtained on a standard salt solution by this method and by the ordinary method showed that readings reliable to the hundredth of a degree centigrade could be got with as little as 0.3 c.c. of solution. The determinations are, of course, less accurate than those made with 10 or 15 c.c., but the method will, it is hoped, permit the approximate measurement of the freezing point of such quantities of blood or serum or of the rarer animal liquids as are easily available for clinical purposes, without diluting with water or salt solution, a procedure to which there are weighty objections.

Preliminary Report on an Attempt to Determine the Oxidizing Coefficients of Different Tissues: H. MCGUIGAN.

The tissues of the body are known to differ in their oxidizing powers. The attempt was made to express the comparative oxidizing powers of the more common sugars in terms of electro-chemical units, with the hope of getting data from which to compute the voltage necessary to relieve the enzymes of their charges and thus indirectly obtain their oxidizing powers (see A. P. Mathews, *Am. Jour. Physiol.*, Vol. X., p. 450). Comparative figures were obtained for lactose, maltose, glucose, galactose and levulose.

Neutral copper acetate will oxidize all of the above sugars in the order given, lactose being the most difficult. The addition of known quantities of acetic acid will prevent the oxidation. The volume of the acid sufficient to do this differs for each of the sugars, increasing from lactose to levu-

lose in the order given above. The constants were taken from the formula:

$$\frac{\text{Cu acetate} \cdot v \frac{100}{\alpha}}{v. \text{ acetic acid} \cdot \frac{100}{\beta}} = K$$

where v is the dilution, α the percentage of copper hydrate at 100° C., and β the percentage of ionized acetic acid. The following values of K were obtained:

Levulose	0.0276
Galactose	0.0185
Glucose	0.0176
Maltose	0.0096
Lactose	0.0078

If we determine K for Barfoed's reagent in the same way, considering that in the use of it we would dilute it about one half, we get 0.0130. This places it between the mono- and disaccharides, where it should be theoretically.

Artificial Production of Heart Rhythm:

DAVID J. LINGLE.

Physiologists believe rhythmic activity can be revived in heart muscle by electrical, mechanical and chemical agencies. These ideas are based on work done by experimenters who ignored the rôle of salt solutions in producing rhythms and used a sodium chloride solution to hold or moisten a heart strip when testing the power of an agent to make it beat. As a sodium chloride solution of itself has this power, a result obtained under these conditions is unsatisfactory because the agent tested has been made to act with another capable of producing the result.

The inference, from work of this kind, that a constant current is a rhythm producer, is not correct. Because when the same constant current is made to pass through two similar strips from the same heart, one in a moist chamber, the other in air, a rhythm appears only in the latter, which is moistened with NaCl solution, to

prevent drying. The other strip with the same current, but without the NaCl solution, remains quiet. (In this experiment the non-polarizable electrodes should be moistened with LiCl solution, otherwise they may hold enough NaCl to start a rhythm.)

The same is true of strips treated with induction shocks, either slowly repeated or tetanizing. With a NaCl solution they start rhythms, but without it they do not. Mechanical tension, either constant or intermittent, will cause rhythms if the suspended strips are moistened with a NaCl solution, but it fails without this. It would seem, then, that the rhythm-producing power of electrical and mechanical agents of this kind is due entirely to the NaCl solution used along with them.

No work along this line has been done to test the powers of the various chemical agents. But as most of these have been used with a solution of NaCl, it will be found, in all probability, that they are not exceptions. Most of them are simply compounds that do not interfere with the action of the NaCl used with them, rather than real rhythm producers.

Experiments on Resuscitation: C. C. GUTHRIE and G. N. STEWART.

Kuliabko's work on resuscitation of the excised mammalian heart after a long interval led us to undertake resuscitation experiments in entire animals. These were begun in the autumn of 1902.

After five to fifteen minutes' complete stoppage of the heart (determined by inspection) by asphyxia, drowning, ether, chloroform or electrical currents, in many cases an efficient circulation was reestablished. A combination of artificial respiration, heart massage, occlusion of the aorta and arterial injection of defibrinated blood gave the best results.

Disappearance of the pulse as deter-

mined by palpation or by the manometer curve does not coincide with complete stoppage of the heart. We saw restoration up to forty-four minutes after the pulse ceased to be felt. Doubtless the period of complete stoppage was shorter.

Before proceeding further it seemed advisable to determine the limit after which resuscitation is possible in particular organs and tissues, especially in the brain and cord. In cats the chest was opened and the innominate and left subclavian arteries, and the aorta immediately below the origin of the left subclavian, were clamped. Artificial respiration was maintained. The heart continued beating well for a considerable time. The reflexes disappeared usually in ten to thirty-five seconds, the respiration about the same time, a few gasps following for a minute or two more. The innominate and left subclavian were released after varying intervals, the aorta remaining clamped. The functions of the anterior part of the animal (including the brain and cervical cord) returned after an interval which was longer the greater the period of occlusion, but dependent also on the efficiency of the circulation. The longest interval after which complete restoration (including voluntary movements, eye reflexes, etc.) has been hitherto obtained is twenty-five and a half minutes. After a fifty minutes' occlusion* excellent respiratory movements returned, together with strong reflex movements of the fore limbs, including good crossed reflexes, jaw reflexes and violent general spasms of the whole anterior part of the animal. The eye reflexes were not restored nor were we certain that any voluntary movements returned.

The symptoms appear in a fairly definite order: (1) some constriction of the pupil; (2) twitching of skin over shoulders, on

lower jaw or head or in the tongue; (3) gasping movements of jaws rapidly increasing in intensity and rate, and soon involving neck, shoulders, chest and fore limbs; (4) eyelid, light, and fore limb reflexes, the latter first confined to the limb struck, but later crossed. The reflex excitability of the anterior portion of the cord is abnormally great; (5) extensor spasms of fore limbs, neck and head (usually opisthotonus); (6) voluntary movements of head, eyes and limbs.

We do not know whether animals after such a long period permanently survive. A cat in which all symptoms of complete anemia of the anterior part of the body were present for five minutes after occluding the innominate and left subclavian arteries, artificial respiration being kept up through a tube inserted through the glottis, recovered completely, although the extensor spasms after the anesthesia had passed off were marked. Another cat after ten minutes' complete anemia had severe spasms and croupy respiration for some hours. The spasms and dyspnoea do not depend on any lack of oxygen in the blood, shown by the appearance of the gums, tongue, etc., and they are not relieved by oxygen inhalation. This animal rapidly recovered, showing only some paralysis of the right limbs, which gradually improved.

Some preliminary experiments have been made on the maintenance of an artificial circulation through the isolated head with the view, among other points, of ultimately investigating the question of cerebral vasomotors. In one case the eye reflexes were still obtained with artificial circulation of defibrinated blood after about nine minutes. As the blood had been kept in the ice box for twenty-four hours after being used for a previous experiment, and as this was one of our earlier experiments, there is no doubt that a much better result can

* This experiment was performed after the presentation of our paper.

be got. Defibrinated blood was found to be better than Locke's solution.

The Nature of Cardiac Inhibition, with Special Reference to the Heart of Limulus: A. J. CARLSON.

It is commonly believed to-day that the cardio-inhibitory nerve-fibers act directly on the heart muscle. This view is a corollary of the myogenic theory of the nature of the heart-beat. In *Limulus* the heart beat is neurogenic. The cardio-inhibitory nerves act on the local heart ganglion in a way to stop or diminish its activity and do not act directly on the heart muscle. This conclusion rests on the following evidence: (1) stimulation of the nerves that pass from the cardiac ganglion to the heart muscle produces motor and not inhibitory effects; (2) the diminution of the excitability of the heart during complete inhibition is the same as after extirpation of the heart ganglion; total inhibition thus amounts to throwing the ganglion out of function; (3) atropin paralyzes the cardio-inhibitory nerves only in case it comes in contact with the heart ganglion, but not if it comes in contact with the heart muscle and the nerves passing from the ganglion to the heart muscle.

Weber's theory of the nature of the cardiac inhibition is thus shown to be true for the *Limulus* heart. Stimulation of cardio-inhibitory nerves in *Limulus* produces the same effects as those produced in the vertebrate heart by stimulation of the vagi. The mechanism of cardiac inhibition in vertebrates probably does not differ from that in *Limulus*, as all the changes produced in the heart by the stimulation of the vagi can be accounted for on Weber's theory. Cardiac inhibition is, therefore, to be referred to the category of inhibitory processes known to take place in the central nervous system, that is, the inhibition of one neural process by another.

Effects of Simultaneous Section of Both Vagi above the Origin of the Recurrent Laryngeal: G. N. STEWART.

1. At the Madrid International Congress of Medicine (April, 1903) Ocaña showed a dog which, ten weeks after this operation, was in perfect health. It remained so for more than six months. He supposes that this was the first instance of such a result. In November, 1900,* however I described similar cases. In February, 1897, a dog was operated on, which lived in excellent health for many months. An account of this animal was sent on March 31, 1897, to a friend for insertion in an eastern medical journal, but was not considered suitable. At the autopsy I found the two portions of the left vagus still separated by a wide interval. In the right vagus such perfect union had taken place that only a fine linear scar remained, barely visible to the eye, but easily recognizable with the aid of a hand lens, and still better on microscopical examination of longitudinal sections. Such instances of perfect recovery and long survival are quite rare, at least in this climate (two, or at most three, cases out of sixty dogs, in my experience). Whether they are to be explained by some anomaly in the distribution of vagus fibers, or by some happy 'conjunction of circumstances,' which enables the animal to survive the critical period, or, what seems less likely, by an abnormally rapid regeneration or partial regeneration of one of the nerves, must be left undecided.

2. In all dogs (including these exceptional cases) after double vagotomy the ratio, pulse rate to respiratory rate is much increased (before operation, 3:1 to 5:1; after operation, 9:1 to 40:1). If the animals live for more than a few days the ratio tends to diminish somewhat through slowing of the pulse. The rate of respiration,

* 'American Yearbook of Medicine,' 1901, p. 548.

except in the anomalous animals that survive indefinitely, shows remarkable constancy even in dogs which live several weeks. Thus, after double vagotomy, a regulation of the heart rate is again developed which tends to bring it back towards the normal, while in the case of the respiration, such a tendency, if it exists, is much feebler. In the exceptional animals the ratio shows a marked tendency, even in the first few days, to return towards normal, both by a diminution in the pulse rate and by an increase in the rate of respiration.

3. After section of the whole of one vagus and about half of the other, the remaining vagus fibers are sufficient to keep the rate of the heart and respiration almost normal. With how small a proportion of vagus fibers intact, dogs (apart from the anomalous cases mentioned) will survive, remains to be determined, although it has been found that artificial stimulation of a comparatively small number of fibers causes the usual effects on the heart and respiration.

The Influence of the Blood Pressure and of Atropin and Nicotin on Experimental Glycosuria: J. J. R. MACLEOD and D. H. DOLLEY. (Preliminary communication.)

The glycosuria which follows puncture of the floor of the fourth ventricle in rabbits can be inhibited by the administration of nicotine. This may act either by paralyzing the synapses of the centrifugal fibers from the so-called glycosuric center as they pass through the upper thoracic sympathetic ganglia, or be due to a fall in blood pressure.

By applying nicotin directly to these ganglia the glycosuria produced by stimulation of the central end of the vagus is also inhibited, but the marked fall in blood pressure which follows the operation necessary for exposing the ganglia, and not the

effect of the drug on the synapses, may be the cause of the inhibition.

In dogs a fall of blood pressure to 40 mm.—produced by hemorrhage—causes the glycosuria produced by stimulation of the central ends of the vagi to disappear.

The injection of nicotin into dogs or rabbits rendered glycosuric by vagal or depressor stimulation does not, as a rule, have any influence in the amount of sugar in the urine.

Atropin has no constant effect either on puncture glycosuria or on that due to stimulation of the vagus or cardiac depressor. Sometimes it causes the amount of sugar in the urine to diminish markedly, at other times it has no effect. No explanation can be offered for this result.

CHAS. W. GREENE,
Secretary.

SCIENTIFIC BOOKS.

The Phase Rule and Its Applications. By ALEX. FINDLAY. With an Introduction to the Study of Physical Chemistry by WILLIAM RAMSAY. 13 x 18 cm.; pp. lxiv + 313. New York, Longmans, Green and Co. 1904. Price, \$1.60.

While physical chemistry in a certain sense is as old as physics or chemistry, the appearance of Ostwald's 'Lehrbuch der allgemeinen Chemie' some twenty years ago really marks the beginning of a new era. Since that time physical chemistry has developed along two quite distinct lines. Van't Hoff brought forward the osmotic pressure theory of solution and Arrhenius the theory of electrolytic dissociation, the two resulting in what may be called the quantitative theory of dilute solutions. Most chemists are fairly familiar with the development of this theory. Not so many people have interested themselves in the second line of work. Roozeboom felt the need of a basis of classification for the numerous double salts and compounds which are met with in inorganic chemistry. He found this in the phase rule of J. Willard Gibbs and he has developed it until it is now seen to be the one